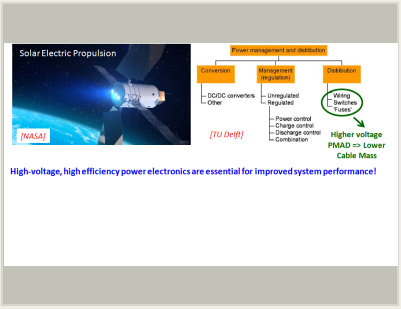
Small Business Innovation Research/Small Business Tech Transfer

Characterization and Mitigation of Radiation and High Temperature Effects in SiC Power Electronics, Phase I

Completed Technology Project (2016 - 2016)

Project Introduction

Future NASA science and exploration missions require significant performance improvements over the state-of-the-art in Power Management and Distribution (PMAD) systems. Space qualified, high voltage power electronics can lead to higher efficiency and reduced mass at the system architecture level, and serve as an enabling technology for operational concepts such as solar electric propulsion. Silicon carbide (SiC) is a robust technology with superior electronic properties for power applications. SiC devices offer higher temperature operation, lower on-resistance, higher breakdown voltages, and higher power conversion efficiency than Silicon power devices. However, high vulnerability to heavy-ion induced degradation and catastrophic failure has precluded this promising technology from space PMAD applications. Importantly, physical mechanisms for this vulnerability are not well understood, resulting in the inability to develop radiation hardened SiC devices. CFDRC, in collaboration with Vanderbilt University and Wolfspeed, a Cree company, will utilize a coupled experimental and physics-based modeling approach to address this challenge. In Phase I, we will perform heavy ion testing of commercial Wolfspeed SiC Schottky diode and power MOSFET to generate response data. Detailed TCAD models for the diode will be developed, validated, and applied to identify physical mechanisms behind measured radiation response. In Phase II, we will focus on SiC power MOSFETs and perform additional heavy ion and total dose testing as a function of temperature and bias. Extensive TCAD modeling will be performed to identify radiation and temperature dependent response mechanisms, and to investigate device structure/process modifications for improved radiation hardness. Promising solutions will be prototyped followed by electrical/radiation characterization. Participation by Wolfspeed in Phase II and beyond will ensure superior space-qualified, SiC power MOSFETs for NASA applications.



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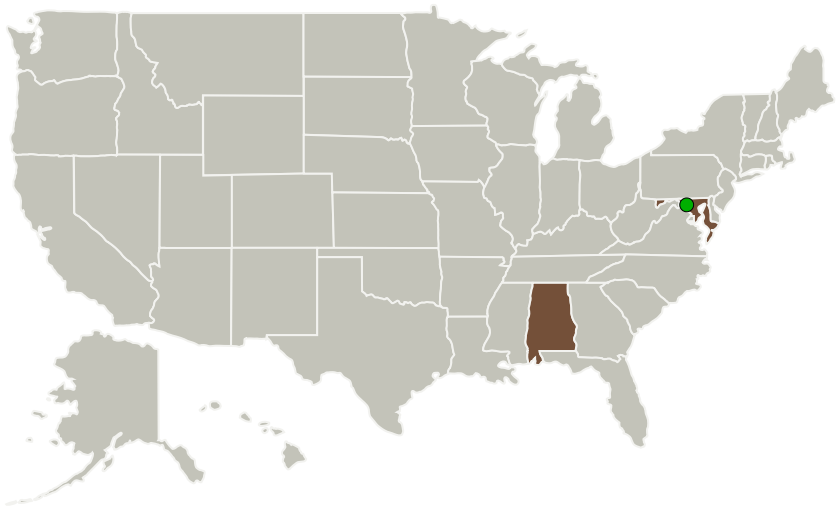
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Alabama	Maryland

Project Transitions

June 2016: Project Start

December 2016: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/139845)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

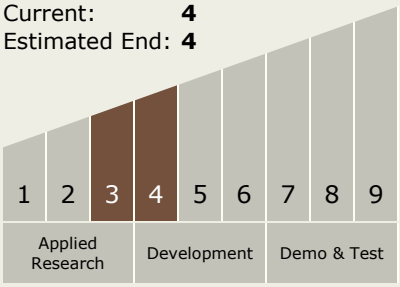
Carlos Torrez

Principal Investigator:

Ashok Raman

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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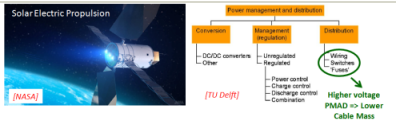
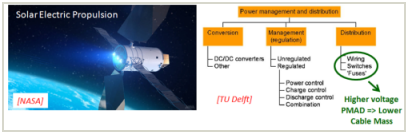
Images



Briefing Chart Image
Characterization and Mitigation of Radiation and High Temperature Effects in SiC Power Electronics, Phase I
(https://techport.nasa.gov/image/132423)



Final Summary Chart Image
Characterization and Mitigation of Radiation and High Temperature Effects in SiC Power Electronics, Phase I Project Image
(https://techport.nasa.gov/image/132751)

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.3 Power Management and Distribution
    - TX03.3.3 Electrical Power Conversion and Regulation

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System